DIRECTOR'S INTRODUCTION

In last year's annual report, I committed to testing that was adequate by any standard, an infrastructure that could support such testing, and "tell-it-like-it-is" reports. This is a "tell-it-like-it-is" report on the status of operational testing within the Department and identifies infrastucture needs to assure adequate testing in the future. Succinctly put, transforming the military requires transforming test and evaluation (T&E).

THE ENVIRONMENT SURROUNDING OPERATIONAL TESTING AND EVALUATION IS CHANGING

Several initiatives are underway that will have significant impact on how the T&E community carries out its responsibilities. An example of such changes is the creation of the Missile Defense Agency (MDA). In January 2002, the Secretary restructured the Ballistic Missile Defense Organization and related programs into MDA and a single integrated Ballistic Missile Defense System (BMDS). MDA implemented the Secretary's guidance to develop a layered BMDS capable of defending the United States, as well as deployed forces, allies, and friends. The strategy was also to use prototypes and test assets to provide early capability, if required in an emergency. Central to this implementation is a concept described as a capabilities-based acquisition strategy.

Capabilities-based acquisition requires detailed assessments of demonstrated operational capability, coupled with a military utility assessment by the user community to support block production and deployment decisions. Under this approach, characterizations of the capabilities demonstrated during each development block replace traditional evaluations of performance compared to user-defined operational requirements. MDA plans a two-year period for each block. The MDA can acknowledge performance shortcomings and field limited capabilities while working to correct identified deficiencies and to develop the objective system.

My assessment for each block will be a characterization of demonstrated capabilities and will point out operational strengths and weaknesses that feed a military utility study. The decision will be made to procure or field in an emergency a block increment after my assessment and the military utility study is complete. This is a significant departure from the traditional acquisition approach in which such decisions are based upon the degree to which demonstrated performance meets specified operational requirements.

We have addressed congressional concerns regarding limitations on DOT&E oversight of MDA efforts through numerous discussions with the MDA, congressional staff, and testimony before the members of Congress. Presently, my staff and technical support personnel have access to all the information necessary to independently evaluate the MDA goals and objectives, assess demonstrated operational capabilities, and determine test program adequacy.

While MDA led the paradigm shift to capabilities-based acquisition, the Services are implementing capabilities-based acquisition strategies under different names. For example, the Army refers to "Blocking Systems" and the Air Force calls it "Seamless Verification." However, congressional concerns about capabilities-based acquisition are stated in the FY03 Defense Authorization Act. This statute limits the programs that can use such an acquisition strategy and requires additional reporting by the Department.

Streamlining the Department's acquisition documents is also affecting the acquisition environment. The Department cancelled acquisition documents signed in May and replaced them with greatly pared down interim guidance documents in September. The Department has new, streamlined documents intended to replace the interim guidance in a final coordination process. While I fully support this effort, the overall impact of this documentation streamlining remains to be seen.

One of my chief concerns is the potential for systems to circumvent the rigorous acquisition process and enter into full-rate production or into the hands of our warfighters without learning the operational capabilities and limitations demonstrated by adequate operational testing and evaluation.

The FY03 Appropriations Bill provided specific direction to Combatant Commands, Services, and the test and evaluation community to perform operational evaluations of Information Assurance (IA) and interoperability during warfighter exercises. Evaluating fielded systems is a change for DOT&E, but not substantially different

from the role of this office during the Y2K operational evaluations. The Department needs this effort to maintain information superiority in the face of the growing information operations threat and rapidly evolving information architectures, even though most systems were adequate in this regard when initially fielded. DOT&E has partnered with the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence (ASD(C3I)) and the Joint Staff to initiate this effort. I am pleased to report that our three organizations, in coordination with Combatant Command and Service representatives, are beginning to implement this direction.

In that context, the above organizations identified candidate FY03-04 exercises for robust operational evaluations including network attacks. These organizations also began to develop a template for IA and interoperability evaluation plans to supplement exercise plans; a plan for Service Red Team enhancement, training, and certification; and metrics to serve the multiple organizations that will benefit or otherwise employ the results of these evaluations. In my FY03 annual report, I will provide an update on the progress of these new efforts and the emerging trends.

I continue to see increased pressure to reduce operational T&E in particular, and T&E in general. I am concerned that emphasis within the acquisition community to control cost and schedule is leading to a practice in which learning about performance is avoided. The cost of testing complex systems, as well as the risk of performance shortfalls delaying programs further, is motivating managers to skimp on testing. Performance results are the product of testing and, if poor, may force further development to correct deficiencies. Additional development inevitably leads to schedule delays and increased cost. Blaming T&E for cost increases and schedule delays is a practice akin to shooting the messenger.

Having said that, I remain convinced that T&E within the Department must change to serve the military transformation goals of the Department. In particular, T&E must transform to be able to provide the warfighters and the acquisition community with timely, affordable, demonstrated performance information. A first step toward that transformation occurred last summer. Spurred by a draft legislative proposal and a review of previous studies, the Deputy Secretary established a Department position that acknowledged, for the first time, the need to assess the adequacy of the T&E infrastructure and the investment and modernization of that infrastructure at the DoD enterprise level. This position was reinforced by the FY03 Defense Authorization Act which prescribed the creation of the Defense Test Resource Management Center as a defense field activity reporting to the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)).

To avoid being viewed as the root cause of cost increases and schedule delays, T&E policies, processes, practices, infrastructure, and the T&E events themselves must not contribute significantly to the length of the planned development cycle. The remainder of this introduction discusses what is needed to maintain adequate testing and improve infrastructure to support testing in the future.

Earlier this past year, the Deputy Secretary directed OSD and the Services to examine T&E modernization and align T&E policies with the new acquisition strategies. As stated before, the Department is implementing new approaches to the development, production, and deployment of military capabilities. When all complexities are considered together, it is appropriate to rethink, as part of a broad review, how T&E would best function in this transformed environment.

To prepare this review, we first identified the common areas that have caused performance problems with new systems. We examined what could be done in testing to mitigate these problems. We considered how new acquisition approaches might affect the problem areas. We examined future weapons and operational concept developments for what should be addressed early to aid the ongoing military transformation. Finally, we identified the investments in resources needed over the next decade in people, processes, and facilities to support that transformation.

During the review, my overarching goal was to make T&E more useful and responsive both to our combat forces and the development process. There are problems in both areas worth describing.

DIRECTOR'S INTRODUCTION

TO SERVE OUR COMBAT FORCES BETTER, WE SHOULD TEST BASED ON THE WAY WE FIGHT, NOT ON HOW WE PROCURE

We need to conduct operational testing and evaluation before a system goes to combat. During the last year, I became concerned about the pressure to deploy new systems that have not been adequately tested. I recognize and agree, in principle, with the desire to field new capabilities as soon as possible, but that desire should be tempered with the responsibility to ensure that the weapons will not put Americans at risk. Part of the problem is that we have not provided adequate resources. As a result, T&E currently cannot be done fast enough to satisfy the desired timelines in the acquisition process. This ought to be a major theme for T&E transformation.

Congressional concern about fielding systems that have not been adequately tested was evident in new legislation that requires this Annual Report to identify waivers or deviations from testing requirements by the Services. There are four cases of deviations from previously approved testing requirements, reported in detail in the sections for the relevant systems: Shadow 200 Tactical Unmanned Aerial Vehicle System, Advanced Amphibious Assault Vehicle, Evolved Sea Sparrow Missile, and the Joint Standoff Weapon Baseline Variant.

We must reinforce the principle that systems that go to war must be tested the way they will be employed. In this respect, T&E should align itself better with the revolution in training that is underway. Just as we train the way we fight; we should test the way we fight. Training is based on a set of principles that have direct application to testing. Those principles include: training should be realistic; training should have a smart opposition force; there should be ground truth recorded; and the lessons learned should be documented. Finally, the training should be conducted in a joint context and with joint scenarios. We should follow these same principles in T&E.

One major finding about testing "the way we fight" is the need for a national joint test capability. The individual Service ranges are too limited and insufficiently interoperable to test in a joint environment consistently and effectively. This need is considered further under the discussion of facilities. We can summarize how T&E can better serve combatants by saying: we should test based on the way we fight, not on how we procure.

TO SERVE THE DEVELOPMENT PROCESS BETTER, WE SHOULD INCREASE THE QUALITY OF TESTING AND DECREASE THE PROGRAMS' TIME AND COST OF TESTING

The second aspect of the overarching goal is to make T&E more useful to the development process. Some of the changes needed to accomplish this goal have been documented in Defense Science Board (DSB) and General Accounting Office (GAO) reports over the last few years. The GAO recommendations included carrying out more testing, and testing earlier and more completely. Many of the obstacles to thorough learning about performance can be attributed to the desire to streamline acquisition. With respect to acquisition, we reviewed test policies, procedures, and practice to ensure they are optimized for our acquisition process and that the test infrastructure is capable of supporting affordable, adequate testing. To make this viable in an environment of high pressure on cost and schedule, it will be necessary for testing to increase its quality, while also decreasing the time and cost of testing to the programs. Achieving this goal depends on people, processes, and facilities.

Testing should be of quality and produce results quickly. It ought to be a continuous process – it should not simply stop when a system goes into production or is deployed. We all say, "We test to learn." If we believe that, why should we stop learning about the equipment with which our men and women are going to war? Why should we stop learning about the equipment the taxpayers are entrusting to us to build and continue to improve? Spiral development and evolutionary acquisition are both forthright in stating that development is never over — that there is always something to learn and improve. Therefore, we should plan for continuous testing, as it will inform engineering changes, evolutionary requirements, and logistics needs.

We can organize the solutions around the actions needed that affect people, processes, and facilities.

People

Without doubt, the highest priority is to attract, retain, and properly use the talented people needed to get the job done as part of the T&E workforce. First, we must reverse the shift away from the involvement of military Tactical Operations and Engineering and Maintenance personnel in operational testing. These are precisely the people we need to provide early feedback to developers.

Secondly, we must provide the ranges and other T&E facilities with a workforce able to deal with advanced technology, address the shortfall in government expertise in a variety of areas, and provide continuity of operations during what I view to be a looming workforce crisis.

For example, at least one test facility, the Utah Test and Training Range (UTTR), is faced with 92 percent of its workforce eligible for retirement in five years. In general, the average age of our T&E workforce is the late forties or early fifties, and there is a void of younger people. The age profile of the OT&E civilian workforce is clearly a cause for concern as only 11 percent of the civilian workforce is under 40.

To address this current and worsening civilian workforce problem, the T&E facilities desperately need innovative approaches such as those advocated by the Under Secretary of Defense for Personnel and Readiness. These innovative approaches include:

- The right to participate in the Demonstration Pay Plans – The pay banding initiatives to allow them to compete better with the private sector.

- The ability to direct hire. (This also helps in the recruiting process.)

The timeline for the reconstitution of the testing workforce is an important aspect of any plan to address this problem. Clearly, the priority we have accorded military transformation puts a premium on short-term remediation. We should assume that hiring 10 percent of the current workforce each year is reasonable, given the demographics and the effect that pay banding might have on workforce turnover. For the next five years, in order to address situations like that of UTTR discussed above, even higher hiring rates might be required, both to address the retirement challenge and to guarantee successful transfer of the existing knowledge and experience base to the next generation.

Bringing operational users into the development process should occur immediately. Each program should have at least one or more operational users assigned, depending on size and complexity of the project and personnel should increase when the system is brought to field testing. Mission performance should be the primary focus of the evaluations done on systems, but several capable individuals will be required if hardware, software, and interoperability are each continuously examined.

An increase in test facility personnel may be needed to prepare for spiral development and evolutionary approaches to acquisition. Every system in the inventory should be undergoing some kind of test as its design, manufacture, or interoperability demands change. We should not repeat the recent experience of a major program office implying that the OT&E was irrelevant after 18 months because of the number of system changes introduced after the Initial Operational Test and Evaluation (IOT&E). Necessary personnel in order to provide continuous testing will ensure performance is verified throughout the life cycle changes from development through deployment.

Processes

The processes that need to change include funding, contracting, and design. They are aimed at permitting us to:

- Test the way we fight, not the way we procure.
- Increase the tempo at which we test.
- Develop common instrumentation.

- Provide earlier real involvement of operational military personnel.
- Test before deployment.
- Make testing more valuable.
- Contribute to evolutionary acquisition and spiral development so that we understand performance before production or fielding.
- Address the shortfall in methodologies for Information Assurance and Interoperability.

A major theme of military transformation has been the recognition of the importance of joint operations. Our testing should recognize that too. All Test and Evaluation Master Plans (TEMPs) should recognize the joint nature of operations to ensure joint requirements are adequately tested. With truly transitional equipment, there is also a great advantage in seeing early on how forces would use the system when developed. Encouraging early, or parallel, development of training systems could foster such experimentation and early experimentation with new concepts of operation. This will help ensure that we test the system the way it would actually be used.

However, testing the way we fight is more than just testing in a joint environment. The physical and threat environments are also important. The process of preparing test plans, ranges, and opposition forces to challenge new systems has to take into account our weapons' increasing range, and the new diversity of scenarios that our forces confront. There no longer is a single relevant scenario, or expected place, for the next conflict. Testing should not focus narrowly on a given scenario but must inform potential users about performance across a much broader spectrum of potential use. This is capabilities-based testing and evaluation.

Programs' cost for testing has risen over the last decade. This has occurred primarily because of changes in the way we are funding the ranges. The current process forces the programs to pay a greater fraction of the cost of testing. This problem is discussed in more detail in the Resources section. Related to this issue, a recent Inspector General (IG) study found that the Department's information on institutional funding and backlog of test assets is so poor that, "program managers may also be lacking the relevant information necessary to make informed test decisions for their programs." The first step in addressing this problem is to establish a common financial system with activity-based costing. The next step is to decrease the cost of testing to programs by increasing the level of institutional funding of the ranges.

Decreasing the testing cost to programs could encourage an increase in the amount of testing during development including reliability testing, software testing, component level testing, and operational concepts testing. A major failing in the recent past, which DOT&E has documented repeatedly, is the large number of immature systems that come to operational test, encounter problems and often fail. Developmental testing must be more effective than it has been in assuring the maturity of systems entering operational testing. As we move to eliminate or reduce redundancy in contractor and government testing in programs, we need to assess our contracting strategies to facilitate the flow of information during early design and development efforts. We should change the contracting structure to allow the government to review, and comment on, contractor test plans, witness contractor testing, and have access to contractor test data and reports. At present these are too often considered proprietary to the contractor.

Other features of the Acquisition Strategy could help speed the information gathering process needed to mature system designs. For example, we should consider the life cycle cost effectiveness of embedded instrumentation, aligned with embedded training, in the design of our systems. Another key consideration is that embedded instrumentation will provide us with many opportunities to examine performance and reliability even after the system is in field use. This is particularly important when the acquisition strategy involves constant improvement, as hoped for in spiral development or evolutionary acquisition.

In fact, all items in the inventory should be under continuous testing so that faults are found before, rather than in, combat. This is "lead-the-fleet" testing. In this process, a few systems are used at a higher rate than usual in order to get information of potential trouble areas before the whole fleet is affected. This is particularly important for systems that are

evolutionary with constantly changing engineering designs. Procurement contracts must include "lead-the-fleet" test articles.

Operational tests are now often conducted using Engineering and Manufacturing Development (EMD) models, and these models are sometimes even shipped to the field for use in operations. As a result, I believe that, in addition to its current responsibility with respect to recommending the number of items needed for test, DOT&E should recommend the number of EMD items needed for testing. This recognizes the reality that often no low-rate initial production items are used in the IOT&E.

One final process improvement that could increase the readiness of ranges and other facilities to test new systems involves the Central Test and Evaluation Improvement Program (CTEIP). We should enhance CTEIP by replacing the Service's "requirements and de-confliction process" with one that takes less time to define a need. While new systems are seldom Service-unique, they are often tested on ranges that have Service-unique instrumentation. We should not develop Service-unique instrumentation for weapons that will be used in Joint Operations.

Facilities

The third component of infrastructure is facilities without which the people and processes cannot work. The DoD IG has reviewed the backlog of maintenance and repair and found cases of significant neglect. To remove that backlog will require a considerable investment. Repair and maintenance may not be the most judicious path. It may be wiser to invest in new equipment to replace the 1960s and 1970s vintage equipment that our ranges too often strive to maintain.

The solutions included in the table below are designed to:

- Address the test needs of military transformation – with its increased emphasis on joint operations.
- Ensure that we can test new weapons, test them before they are deployed, and test them realistically and in the right environments.

Again, the goal of a successful military transformation and the needs of the war on terrorism are important timeline drivers. However, the realities of planning for improvement are such that a 10-20 percent increase in the funding to ranges (above that to provide increased institutional funding) could be absorbed in the FY05 budget. Larger increases will be needed after that to actually implement the developments.

SOLUTIONS TO ADDRESS ACQUISITION PROBLEMS

The above sections suggest a large number of improvements that have made themselves evident when considering the real acquisition problems faced by real programs. I have found that there are systemic problems shared across the spectrum of weapon system types as well as problems that are specialized to particular warfare areas. While it is not necessary to understand how the problems and solutions are connected to appreciate the magnitude of the task, it does help in justifying those solutions. First, the systemic problems are addressed and problems in particular warfare areas are treated in summary form, with more details provided in the Resources Section of this report.

Systemic Problems

Some performance problems arise from causes shared across the whole spectrum of weapon system types. For the most part, these problems are associated with the acquisition system in general rather than any particular weapon system. They are discussed primarily in the context of their implications for T&E transformation. The solutions will involve changes to the three components of the T&E infrastructure: people, processes, and facilities. In addition, solutions will require some change in the acquisition processes beyond those in T&E.

The inability to reliably identify immature technology could be alleviated if the T&E workforce were more technically expert and more familiar with the newest technology. This expertise should be expected of the testing infrastructure. To develop it, T&E should become familiar with and use advanced technologies in its own instrumentation. T&E should

anticipate new technologies to be ready to test them when they appear at the ranges. The T&E infrastructure should stay ahead of the acquisition systems in the sophistication of the technology with which it deals. I call this a capability-based testing infrastructure in analogy with some acquisition strategies that are not based on requirements, but on capabilities.

There is a critical need for technologically expert personnel who could carry out such research and development to support our T&E capability. Our test facilities must be able to attract, hire, and retain a quality technical workforce. The kinds of activities this workforce should pursue include many of those we are promoting in the Test and Evaluation/ Science and Technology program: embedded instrumentation, nanotechnology, hypersonics, etc.

Investments in testing should be forward-looking, incorporating leading-edge technologies as rapidly as possible, just as weapons systems are moving to incorporate new technologies as rapidly as possible. In such an environment, if testers wait to define testing requirements until the new technology is already in the system under test, the tester will never be ready to test new capabilities adequately.

Current instrumentation maintenance practices are not forward looking. We must introduce leading-edge technology into the T&E infrastructure. This will have the secondary benefit of ensuring a corporate knowledge within government of the real-world capabilities and limitations of those technologies.

Failure of feedback loops is another common cause of performance problems. It is the failure to translate successfully what is learned from testing into changes, either engineering or operational, as a result of what is learned. In the case of Joint Standoff Weapon, the Navy test report recommended the program office "Conduct analysis to determine overall benefit of correcting wind estimator error." Failure to take any action led to weapon misses experienced in air attacks on Iraq in January 2001. These problems can be attributed to a failure to integrate testing well into Systems Engineering. We should insist that expert government evaluation is available and shared with the contractor, starting at the component level. Even components can be tested in a "realistic" environment if enough is known about the system concept.

Throughout the last decade, there has been a push to provide earlier operator feedback to the development process. The Air Force is striving to institutionalize this initiative in an approach it calls "Seamless Verification." Providing airmen to work T&E issues early on is beneficial. This may help reverse a trend identified in a March 2002 study by the Institute for Defense Analyses (IDA), which found a significant shift away from Tactical Operations Officers; down from 41 percent of the officer workforce in 1990, to 33 percent in FY00. The biggest challenge that DoD T&E will have to meet is the need to provide more of the right kind of personnel for earlier involvement with programs. The same IDA study concluded, after examining all the Operational Test Agencies, "The reduction in the military presence in OT&E and the move away from tactical operations and engineering and maintenance officer billets suggest cause for concern…"

In summary, we need to put soldiers, sailors, airmen, and Marines who are operators, back into the development process for systems. The first step is to recognize that testers are not "acquirers," and that they should be independent from them. In that context, workforce positions for testers should be separate from acquisition corps positions.

Insufficient or inadequate Developmental testing can often be traced to the cost and schedule pressures on program management. Unfortunately, problems revealed late in testing can become a major source of cost and schedule issues. A GAO evaluation of DoD test and evaluation processes concluded that "Several factors weaken the contribution testing and evaluation make, particularly early in the program. These include the disruptive effects of attempting to develop technology concurrently with the product; optimistic assumptions embedded in test plans; and the fact that testing and evaluation is not viewed or funded as being central to the success of the weapons system." A change in DoD Directive 3200.11 and the financial activities regulations may be necessary to provide incentives to program offices planning and funding testing and seeking relief from the rising cost of testing.

The lack of adequate reliability testing is a particular case of insufficient developmental testing. Evidence of insufficient development testing has been demonstrated, in cases where the data has been kept, by the high reliability failure rate of systems when they enter operational test. The National Research Council concluded in 1998, "The Department of Defense and the military services should give increased attention to their reliability, availability, and maintainability data collection

and analysis procedures because deficiencies continue to be responsible for many of the current field problems and concerns about military readiness." This was serious enough that DOT&E asked the National Academy of Sciences to investigate further. The Academy produced two reports, one on reliability in general, and a second on software reliability, a separate and special problem deserving attention in its own right. They concluded reliability problems should be addressed in the design phase and include early-on testing starting with components. To accomplish this, contracts need to be tailored to allow the government access to component and subcomponent test data.

In addition, increased emphasis on hardware-in-the-loop testing could improve the process. Test facilities should include the capability to make such testing affordable, easy, and quick. Coupled with the reliability problem is the problem of insufficient maintainability testing. We should have a force of expert reliability engineers to allow for every test event to have a reliability component. Unfortunately, too often test events are planned without collection of reliability data. The National Academy report made two significant comments: the Department's reliability tracking methods are significantly out of date, and industry has found collection and analysis of data after the system has entered the market to be of significant benefit.

Early commitment to investment in embedded instrumentation will yield information returns throughout the life cycle of a program. New DoD acquisition strategies such as spiral development and evolutionary acquisition are built around the idea that the design is never finished since improvements are continuously introduced. In such situations, the need for continuous learning from testing is clear. With respect to reliability, we can say we test to learn and need continuous learning. This means we should have continuous, ongoing data collection and testing of all fielded equipment to learn where the next dollar of improvement could provide the greatest value in terms of performance. DoD should be prepared to continue to collect data on all systems even after the full-rate production decision is made.

For modern systems development, the configuration of the weapon is constantly subject to change. The Army helicopter community has tacitly agreed with this assessment and re-instituted the practice of "lead-the-fleet" testing. This is a useful process for many system types, not just helicopters. Our procurement contracts should include "lead-the-fleet" test articles.

Inability to track and evaluate software is the subject of a recent National Academy of Sciences report. The report suggested a number of improvements. The major impact will be on the need to hire software experts capable of evaluating software architectures and designs. In this area, the test facilities are critically deficient. Our testing infrastructure is designed around hardware; and increasingly, as evidenced in numerous programs, software is a critical development, integration, and performance-driving component.

Insufficient prototypes and other test resources have slowed the pace of testing and put pressure on program managers to drop tests. This was the tragic case with the V-22 testing as reported in the accident investigation, and contributes significantly to our desire to increase the tempo of testing and reduce the cost to programs so that program managers are not placed in a position where they are forced to choose between adequate testing, and cost or schedule. Existing legislation requires DOT&E to determine the number of LRIP items required for operational testing. More rigorous attention to the number of production representative items needed for testing, whether they be EMD or LRIP, might avoid problems with test schedules in the future. We have seen decisions to cut test assets to save money in the short-term result in long-term delays in the developmental test program.

We must address the adequacy of our engineering workforce and technical human resources. The proper way to do this is to begin to correct the demographics of the workforce so that it becomes more stable. Technical expertise is needed in a number of areas including flight safety, software, chemical and biological research, and mathematical and statistical analyses.

Late and inadequate evaluation of training is also a common problem. The Army has decided, tentatively, to try to reverse the process and insist that training systems actually precede the hardware/software. There are good systems engineering reasons for hoping that, by keeping training devices up front, what is built the first time is what the soldier will find most

useful. This should be a general goal for all the Services.

Encroachment on land, sea, and air space, as well as the frequency spectrum, is a major problem. In the frequency spectrum, we will need to balance trying to do better in the bands that are left for us and, moving to bands that are of less commercial value. The problem is real; the ranges already delay tests because they do not have enough spectrum to run them simultaneously. The Department is addressing the general problem of encroachment under the rubric "Sustainable Ranges." Both testing and training ranges are affected, and the Under Secretary of Defense for Personnel and Readiness and I together share responsibility for that effort.

Hardware/software integration continues to be a significant problem and is getting worse as software-intensive systems become prevalent. Our ability to test systems-of-systems requires new methodologies and new infrastructure.

A slow tempo of testing increases the chances that programs that are driven by schedules will tend to forego sufficient testing and its associated learning. An industry test manager quoted in a study of commercial best practices for the Office of the USD(AT&L) expressed the conflict in commercial industry simply, "If something doesn't have to work, we can ship it tomorrow." In general, test avoidance only delays the recognition of problems and increases the cost to fix them. Increasing the tempo of testing involves increasing the resources for test execution, and the available means to move, share, and analyze data and improved test design. Many of the CTEIP activities begun in the last few years have this goal in mind. We also need to increase the number of personnel available to surge testing when that is necessary. This also means using common practices and procedures and interoperable equipment and instrumentation throughout our test facilities and ranges.

Lack of interoperability of our weapons systems, we are beginning to realize, begins with the basics. Individual test ranges typically have a Service-centered focus. If T&E ranges do not interoperate, chances are the systems will not either. Several of our test ranges have different and incompatible data collection formats, data rates, and telemetry systems. The CTEIP program has been working through its Foundation Initiative to improve inter-range interoperability. CTEIP and its Foundation Initiative played a key role in making *Millennium Challenge 02* a reality. It was the glue that held the exercise together by linking together the testing and training ranges and by linking the ranges back to the exercise control center. That inter-range interoperability should be extended. What is needed is a Joint Test & Evaluation Capability. The design and procurement of new instrumentation have to be harmonized and recognized as areas needing national focus. Common instrumentation that allows ranges to interoperate when needed also cuts the cost of modernization by leveraging larger buys. One trend that seems to be emerging and should be encouraged is the preference for mobile instrumentation, rather than fixed sites.

We must improve our data sharing and transmission capabilities. It now takes three to four days to transmit data from Kwajalein to the Continental United States (CONUS) for analysis. There are plans for improvement, but we need an order of magnitude improvement on that front. Data sharing will be key to range interoperability in the near term, linking test and training ranges. I hope to see both Kwajalein and the Atlantic Undersea Test and Evaluation Center (AUTEC) as leaders in this effort, in the process increasing the productivity of scientists, engineers, and developers at their home stations in Massachusetts, Rhode Island, and elsewhere in CONUS.

Acquisition strategies such as spiral development and evolutionary acquisition will require data archiving with a reliability for reuse that we have not seen before now. We should move to develop such a central repository.

The financial accounting system has to change. At present the main function of the accounting system is to trace where the money goes, not for what the money is spent. Thus it is possible to account for spending without knowing how much a test on a particular system costs or how to compare costs, if investment decisions have to be made. This year we asked the Inspector General to examine the records of the Major Range and Test Facilities. They concluded that it was impossible to compare costs from range-to-range because of differences in the accounting systems. The lack of visibility into actual test costs is a major concern. Fortunately visibility can be gained without putting disincentives in the way of the adequate funding of test programs. Visibility, which will be an essential ingredient in financial management, can be

achieved by activity-based costing, which should be our principal financial model.

The Department has begun a five-year effort to modernize the cost accounting system. The effort, optimistically, will take until 2007. Legislation requires T&E to have such a common system in place by FY04-FY06. The goal of the system is to be able to account for the cost of tests so that Defense-wide investment strategies can be developed, and so that we can account for what testing is costing the taxpayer.

Particular Test Capability Problems

The generic needs discussed are not the only needs that can be identified. Particular systems and classes of systems have suffered, or will suffer, from limitations in the test ranges and facilities. These are addressed in the section on Resources. The significant changes needed in each warfare area are summarized in the table.

WARFARE AREA	MAJOR NEEDS
Land Warfare Testing	Bigger ranges, "Joint" Instrumentation, Urban and Tropical Testing.
Air Warfare Testing	Real "Operational" Testing, Improved Electronic Warfare Testing, Targets, Hypersonics, Testing Before Deployment.
Surface Warfare and Air Defense	Self-Defense Test Ship, Targets, Range-Size.
Underwater Warfare	Shallow Water Test Capability, Realistic Targets.
C4ISR Testing	Information Assurance and Interoperability Methodologies.
Space Program Testing	A Space Test Range.
Missile Defense Testing	Methodologies and Evaluation Plans, Integrating into the rest of the Infrastructure, Directed Energy Testing.
Chemical-Biological Testing	Test facilities and Methodologies, Government Personnel and Expertise.

CONCLUSION

We must re-examine our T&E policies, processes, and capabilities if we are to meet the challenges of transforming the U.S. military. We must keep what works, discard what does not, and remain flexible in adapting to new requirements. We cannot accomplish this without a corporate approach to policies, processes, and investment priorities. The plan to do the things we have discussed is not business-as-usual.

The T&E infrastructure needs modernization and repair. The backlog in maintenance and repair will ultimately affect our ability to test adequately. This year has seen weapons deployed without adequate testing due to the pressures of war, and we see these pressures continuing. To respond effectively, we must modernize our T&E infrastructure.

Last year we got agreement on specific investments for selected test programs. In general, the Service-proposed FY04 budgets for the T&E infrastructure appear to be higher this year than last. All this is good, but further increases will be required to meet the recommendations accepted by the Deputy Secretary. The Department needs a more comprehensive approach, harmonized among the test facilities and the Services - a comprehensive approach that looks beyond the crisis of the next program milestone.

DIRECTOR'S INTRODUCTION

DoD is transforming to meet the dynamic operational requirements of the war on terrorism as well as future high-technology conflict. This transformation is not limited to new hardware and technological innovation. It also involves transforming our capabilities through operational innovation. The future T&E infrastructure should comprise a comprehensive suite of joint, interoperable capabilities that provide a spectrum of full and realistic opportunities to test new technologies, improved platforms, and innovative tactics and training methods. We face a strong challenge to recruit and retain personnel, define and implement innovative T&E processes, maintain and recapitalize an adequate T&E infrastructure, and transform our capabilities to meet the demands of the future.

Thomas P. Christie
Director